Gopher Intrusion In Cropping Systems

A Senior Project
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Abstract

The purpose of this project was to determine if no till vs. till on gopher populations was more beneficial. Which is more efficient at controlling gophers and explain the damage they can cause and the diseases they can potentially vector. What are the different options of pest managements that have to be used when dealing with a gopher infestation in a tilled field vs. a no-tilled field.

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Chapter One

Introduction

California is the number one cash receipt producing state in agriculture. California has the moderate climate creating the best for crop production. Full with row crops, fruits, grains, nuts, and livestock contributing to 44.7 billion dollars (California). With all the farming commodities for growth of crops there are a large amount of pests in the state that prevent the highest yield. **"**Vertebrate pests while not as numerous or pervasive as disease or invertebrate problems, can occasionally be a real concern.

A pest can be defined as an organism that causes, or is perceived to cause, or is likely to cause economic or aesthetic damage to humans or their property" (Pehling). These pests feed on the roots of the crop, stems, and the fruit. **"**Vertebrate that can cause significant damage by feeding on fruit and on tree bark and shoots, which can stunt growth or kill trees. Some pests will chew or destroy flexible irrigation lines and emitters. Other pests will dig holes through the soil surface, thereby channeling surface irrigation water to undesired areas. Food safety also becomes an issue if pest residues come into contact with the fruit. The major vertebrate pests are pocket gophers, California ground squirrel, and black-tailed jackrabbit. Occasional pests include coyotes, voles, roof rats, wild hogs, deer, and starlings" (Marsh).

The pests decrease value of the crop, decreases the profit margin from production, more input cost and decreased profit from sales. Also affecting drip irrigation chewing through the lines, which in turn more cost for production input trying to grow the crops while the pests are damaging the equipment to do. Vertebrate pests can be difficult to control while following the correct laws and regulations relating to controlling pests in farmland. Vertebrate Pest management laws and regulations are not as strict as invertebrates and pathogens. Mainly baits and traps control vertebrate pests, for pocket gophers control applications are done below ground with baits. Not causing serious immediate harm to humans and other animals near the farms. While invertebrates and pathogens use pesticides and fungicides. The endangered species act protects animals from going extinct. This ties into vertebrate pest management because if there are endangered species near the application site you have to take certain precautions such as not using certain poison baits or setting certain traps if there are endangered species in the area.

There are various traps used in gopher pest management. Traps are a great way to see your methods working because you have a body count unlike baits. Trapping tends to be more fulfilling to because of that body count, but aren't always quite as effective in large-scale operations for different reasons. First off they tend to be much more expensive and when you're dealing with issues of 100 or more gophers you might end up spending more than what the damage they're are causing is worth. Traps worthy of noting are The Black hole trap and the Maccabe trap. The Black Hole trap mimics an extension of a their burrow but has a lever that when touched a metal bars swings down and breaking their spine, an instant death. The black hole always is semi enclosed so there is no direct contact with the rodent, which benefits the handler (Marsh).

Statement of The Problem

Vertebrate pests are everywhere in agriculture, with these high amounts of pests they can cause a lot of damage to the crops and equipment. It is important to keep the numbers down for the pocket gophers to prevent economic loss and environmental damage to the soil. With the soil dwelling pocket gophers they can be treated with the traps and proper baiting schemes. The problem with pocket gophers is if they are in high numbers they can take over a whole farm, damage the soil, destroy the crops, and leave farmers with a declining profit year after year.

The Purpose of the project

The purpose of this project is to determine whether tilled or no-till soil would be more beneficial or less beneficial for the farmer to control pocket gophers. This project will give future PCAs, farmers with a general issue with pocket gophers in cropping systems the tools and the knowledge to keep these pests at bay and to help sustain agriculture for many years to come.

Objectives of the project

1. Survey both farms, tilled and non-tilled for damage by pocket gophers.
2. Record numbers of holes make by pocket gophers.
3. Observe neighboring lands for signs of pocket gophers.
4. Record acreage of farm being used.
5. Trap and bait tilled and non-tilled soil.
6. Record numbers of trapped gophers tiled and non-tilled.
7. Follow up trapping and baiting every two weeks.
8. Record final results after 8 weeks.
9. Determine results, tilled vs. Non-tilled

Definition of important terms

- **IPM**

  Integrated pest management is an alternative process way to control many agricultural management issues and pests. Integrated pest management, or IPM, is a process you can use to solve pest problems while minimizing risks to people and the environment. IPM can be used to manage all kinds of pests anywhere—in urban, agricultural, and wild land or natural areas

- **Gophers**

  Pocket gophers are found in urban and farmland causing damage in their underground activities feeding on roots of almost every plant/ vegetable. Pocket gophers are stout-bodied, short-legged rodents capable of digging through the soil easily.

- **Vertebrate pests**

  "Vertebrate pests while not as numerous or pervasive as disease or invertebrate problems, can occasionally be a real concern. A pest can be defined as an organism that causes, or is perceived to cause, or is likely to cause economic or aesthetic damage to humans or their property" (Pehling).

- **Pesticide Control Advisor**

  "An Agricultural Pest Control Adviser (PCA) is any person who offers a recommendation on any agricultural use, holds himself/herself as an authority on any agricultural use, or solicits services or sales for any agricultural use (Food and Agricultural Code sections 11410, 11411)" (State of California).

Hypothesis

The hypothesis for this experiment is the pocket gopher destruction will be worse in the no tilled soil due to the fact that their holes will be much more stable and extensive and harder to destroy.

Summary

With California being the number one agricultural producing state there must be ways to defend agriculture from pests. Vertebrate pest for example, pocket gophers, are damaging and will cause problems for anyone in agriculture. The pests decrease value of the crop, decreases the profit margin from production, more input cost and decreased profit from sales. Keeping the numbers down for the pocket gophers to prevent economic loss and environmental damage to the soil. With the soil dwelling pocket gophers they can be treated with the traps and proper baiting schemes. The problem with pocket gophers is if they are in high numbers they can take over a whole farm, damage the soil, destroy the crops, and leave farmers with a declining profit year after year.

Determining whether tilled or no-till soil would be more beneficial or less beneficial for the farmer to control pocket gophers. By collecting the data from the project future PCA's and farmers will be able to reference the material collected to help control their farms. Determining whether to till or not to till based on the information will educate farmers and PCA's to help with their further agricultural production to keep a steady profit and not to loose their money from vertebrate pests.

Chapter Two Literature Review

Introduction

The goal of this project is to determine if vertebrate pest management of gophers in till vs. no-till soil causes more or less damage.

Agriculture in California

California is the number one cash receipt producing state in agriculture. California has the moderate mediterranean climate creating the best for crop production. Full with row crops, fruits, grains, nuts, and livestock contributing to 44.7 billion dollars (California). "California accounts for 65 percent of the U.S. non-citrus fruit and nut production and 73 percent of the national value" (California). "California's floriculture crop leads the nation with a value of $974 million in sales, for operations with more than $100,000 in sales, comprising 24.4 percent of the U.S. total wholesale value" (California) "California's total livestock and livestock products cash receipts were $12.2 billion in 2012. Livestock and poultry account for nearly 27 percent of the state's gross cash receipts" (California). California agriculture is a strong commodity throughout the whole state supplying the state and the nation with food. California contributes 25.4 million acres of farmland, with an average of 316 acres, for agricultural production (California).

Vertebrate pests in agriculture

Definition

“Vertebrate pests while not as numerous or pervasive as disease or invertebrate problems, can occasionally be a real concern. A pest can be defined as an organism that causes, or is perceived to cause, or is likely to cause economic or aesthetic damage to humans or their property” (Pehling).

Damage

“Vertebrate that can cause significant damage by feeding on fruit and on tree bark and shoots, which can stunt growth or kill trees. Some pests will chew or destroy flexible irrigation lines and emitters. Other pests will dig holes through the soil surface, thereby channeling surface irrigation water to undesired areas. Food safety also becomes an issue if pest residues come into contact with the fruit. The major vertebrate pests are pocket gophers, California ground squirrel, and black-tailed jackrabbit. Occasional pests include coyotes, voles, roof rats, wild hogs, deer, and starlings” (Marsh).

Careers in vertebrate pest management

An Agricultural Pest Control Adviser (PCA) is any person who offers a recommendation on any agricultural use, holds himself/herself as an authority on any agricultural use, or solicits services or sales for any agricultural use (Food and Agricultural Code sections 11410, 11411) (State of California).

Laws and Regulations in pest management

The endangered species act protects animals from going extinct. This ties into vertebrate pest management because if there are endangered species near the application site you have to take certain precautions such as not using certain poison baits or setting certain traps if there are endangered species in the area.

Endangered species near application area: The ESA, a groundbreaking law signed by President Nixon on December 28, 1973, calls for the U.S. government to bear the responsibility of "safeguarding, for the benefit of all citizens, the Nation's heritage in fish, wildlife, and plants." Under the act, the government or any citizen or citizen group has the power to petition that a species be considered as a candidate for listing as "endangered" or "threatened." Once a species is listed, the U.S. Fish and Wildlife Service (USFWS) is required to develop a plan for conservation and recovery of the species and designate habitat critical to its survival. Today the ESA is the major tool in species protection in the United States and a model for wildlife conservation around the globe. "Without the act, hundreds or even thousands of species would be extinct," asserts Galvin. "It's nature's last line of defense." (Endangered Species)

Gophers

Pocket gophers are found in urban and farmland causing damage in their underground activities feeding on roots of almost every plant/ vegetable. Pocket gophers are stout-bodied, short-legged rodents capable of digging through the soil easily. These rodents have external fur-lined cheek pouches that open outside of the lips, on each side of the mouth, and are used to carry and store food. The gophers are 6 to 8 inches long with a wiry haired tail. Female gophers can reproduce two litters in a year with litters averaging at five young gophers (Micke).

Gophers thrive and dwell in areas of abundant plant growth, while consuming primarily on the succulent underground parts of the plants. Gophers are capable of pulling under a 2-foot tall plant to consume it. Gophers primarily live underground and in solitude. When you find them above ground they are normally out looking for a mate during the breeding season. The burrowing systems are extensive and include deep main burrows, shallow feeding tunnels, and side tunnels to push dirt out. The soil mounds found above their tunnels are easily identifiable. The main tunnels of produced by the Gophers are 10 to 12 inches deep in the soil, while others are much deeper meant for nests and storage chambers for their food. These rodents plug the opening of the burrows to create an enclosed tunnel system in order to keep temperature and humidity at the optimal level (Micke).

Economic damage

Economic damage can be difficult to determine with gophers. Gophers do decrease yields just depends on the density of the rodents per acre of land. “Economic assessment should also be made to determine the cost of no control, the speed of pocket gopher infestation, and the costs associated with dulled or plugged mowing machinery or mechanical breakdowns caused by the mounds. Assessment could also be made for damages to buried cable, irrigation structures, trees, and so on” (Case and Jasch, 1994). The distribution of gophers makes it unlikely that control measures will threaten them with extinction. On the other hand, it may be effective to simply reduce a population. There are also times when control is not cost-effective and therefore inadvisable” (Case and Jasch).

Disease

“Gophers are not considered to be a significant source of any infectious disease transmittable to humans or domestic animals” (Link). Parasites of northern pocket gophers include various species of fleas chewing lice. “Mites, ticks, and a few endoparasites have also been found to parasitize northern pocket gophers” (Verts and Carraway). The northern pocket gopher has been found to be infested with warbles of the botfly, and occasionally infestations can involve 25-37% of populations and be sufficiently intense to cause mortalities (Richens).

Control methods

Traps

There are various traps used in gopher pest management. Traps are a great way to see your methods working because you have a body count unlike baits. Trapping tends to be more fulfilling, but aren't always quite as effective in large-scale operations for different reasons. First off they tend to be much more expensive and when you're dealing with issues of 100 or more gophers you might end up spending more than what the damage they're are causing is worth. Traps worthy of noting are The Black hole trap and the Maccabe trap. The Black Hole trap mimics an extension of a their burrow but has a lever that when touched a metal bars swings down and breaking their spine, an instant death. The black hole always is semi enclosed so there is no direct contact with the rodent, which benefits the handler (Marsh).

> Traps, either pincher or box type, are effective. But because trapping is labor- intensive, they are most commonly used where only a few pocket gophers are present. To locate the main runway or tunnel, probe with a steel rod a short distance in front of the low side of a fresh mound or between two fresh mounds. After you find the main tunnel, dig a hole to intercept it (the hole will probably be 10 to 12 inches deep). Then clean out the burrow and set two traps in the runway, one facing each direction. Whether you use Macabee traps or traps similar to them, wire each pair to a stake so the captured gopher cannot drag them down the tunnel, replace the soil. (Marsh)

Burrow destruction

Burrow destruction is important part of gopher management. Gophers will take over an old unoccupied burrow and continue the damage they are doing. There are a few different methods of burrow destructions the cheapest and easiest methods also tends to be the most enjoyable. There is a device called a Rodenator it is used for all types rodent burrow destruction it involves propane gas tank and a oxygen gas tank mixed together through tubes and made into a wand that is push into the burrow and then detonated with a spark of electricity, which collapses the burrow and kills whatever is inside (Marsh)

IPM

Integrated pest management is better way to handle many agricultural management issues because of how good it is for the environment. The way IPM gets put into use in vertebrate pest management is if you have a rodent infestation such as gophers. Installing owl boxes, which is cheap and easy. Naturally nature will take care of the rodent problem by owls making home in their boxes that were provided this can eliminate any use of traps or poisons which can take care of any issues if there are endangered species in the area that is being treated.

Integrated pest management (IPM) is an ecosystem-based strategy that focuses on long-term prevention of pests or their damage through a combination of techniques such as biological control, habitat manipulation, modification of cultural practices, and use of resistant varieties.

Pesticides are used only after monitoring indicates they are needed according to established guidelines, and treatments are made with the goal of removing only the target organism. Pest control materials are selected and applied in a manner that minimizes risks to human health, beneficial and non-target organisms, and the environment (University Of California).

Chapter Three

Method and Materials

Introduction

In order to complete a senior project one must pick a project that will be interesting and realistic, one that can be completed in a fairly short amount of time. The topic of this senior project is gopher intrusion in cropping systems. Senior project consists of three different classes to prepare, construct, and finish the senior project. Second step would be to research valuable information on gophers, cropping systems, tilling, no-till soils, environmental effects, and methods of control for gophers. Lastly observe and note the differences in gopher activity in till and non-till soil. This senior project is a research-based project.

Gopher intrusion in cropping systems

This topic was chosen because it affects all types of agriculture, this can be damaging and has very little research done on it. This is important because unless more research is done it will keep affecting cropping systems for years to come. It also is compliable in an amount of time that is given to do a senior project.

Research

Researching the information on gophers and cropping systems to understand clearly the harmful effects of gophers on crops. Also research the different types of farming practices with tilling and non-till soil. Laws and regulations of gopher management also need to be researched to help future growers or researchers who read this senior project.

Gopher intrusion on California Polytechnic State University campus

Gopher intrusion can be found in nearly every cropping system. On Cal Poly's campus there are many different fields where gophers are present. The question that is wanted answered is what do gopher move better through? Tilled soil vs. no Tilled soil. The areas on campus that were that were chosen were a newly planted Apricots orchard that was freshly tilled and an old citrus orchard on top of radio tower hill that sees no tilling of soil.

Observe gopher activity

First gopher mounds were located on each of the two areas that were chosen and marked with flags that were used to plot gopher activity in each orchard, till soil and non-till soil, and distance of holes were measured to determine how much they are traveling. Observe the gopher activity for eight weeks to determine the effects of in tillage types.

Chapter Four

Results and Discussion Introduction

The following senior project is a research-based project. The two locations, tilled and non-tilled soil, to determine if tilling or non-tilling have an advantage or disadvantage to managing gophers within a cropping system. The data was observed and taken note for eight weeks. There was an initial consensus took and every two weeks to check on mounds and mark each mound with a flag so bi-weekly results were taken on how much movement was done and an estimate on how many gophers were present in a certain area. The data for the till soil is located below in table 1 showing the dates observed, number of holes and how far the gophers are moving within the soil to new holes. The supplemental images below show the area that has been observed. Image 1 shows the area for the tilled soil in a recently planted apricot orchard. Image 2 shows the area for the no-till orchard.

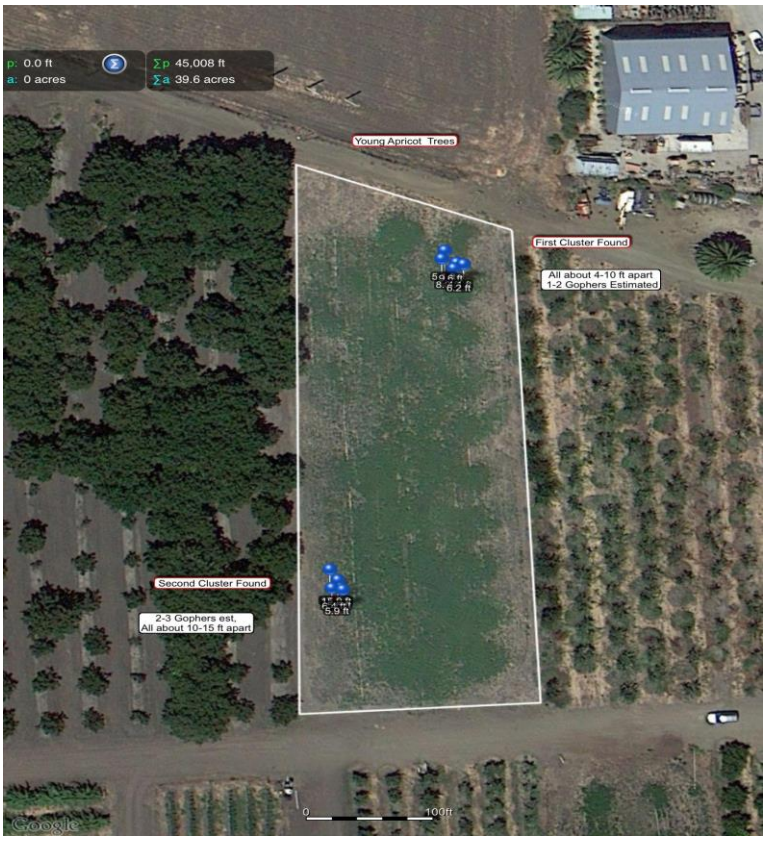

Figure 1: Tilled Soil Area

The area for the experiment in the tilled soil was near the crops unit on Cal Poly's campus. There is an aerial view of the field outlined by a white line (See figure 1). The field is abut an acre and planted with young apricot trees. The study was conducted over nine weeks and the results of the gopher activity are recorded below.

Table 1: Tilled Soil Data

This table above shows the gopher intrusion in tilled soil, the number of holes, and the amount of movement week by week. The Gophers were able to move more freely in the tilled soil, the gophers on average moved of 17.6 inches through the soil.

Date	Number of Holes	Movement in Inches
28 September 2015	23	8-12 inches from old holes
12 October 2015	27	11-18 inches from old holes
26 October 2015	27	No movement *heavy rainfall
9 November 2015	30	20-26 inches from old holes
30 November 2015	32	28-32 inches from old holes

Figure: 1.2

Applying flags to gopher holes in the tilled soil.

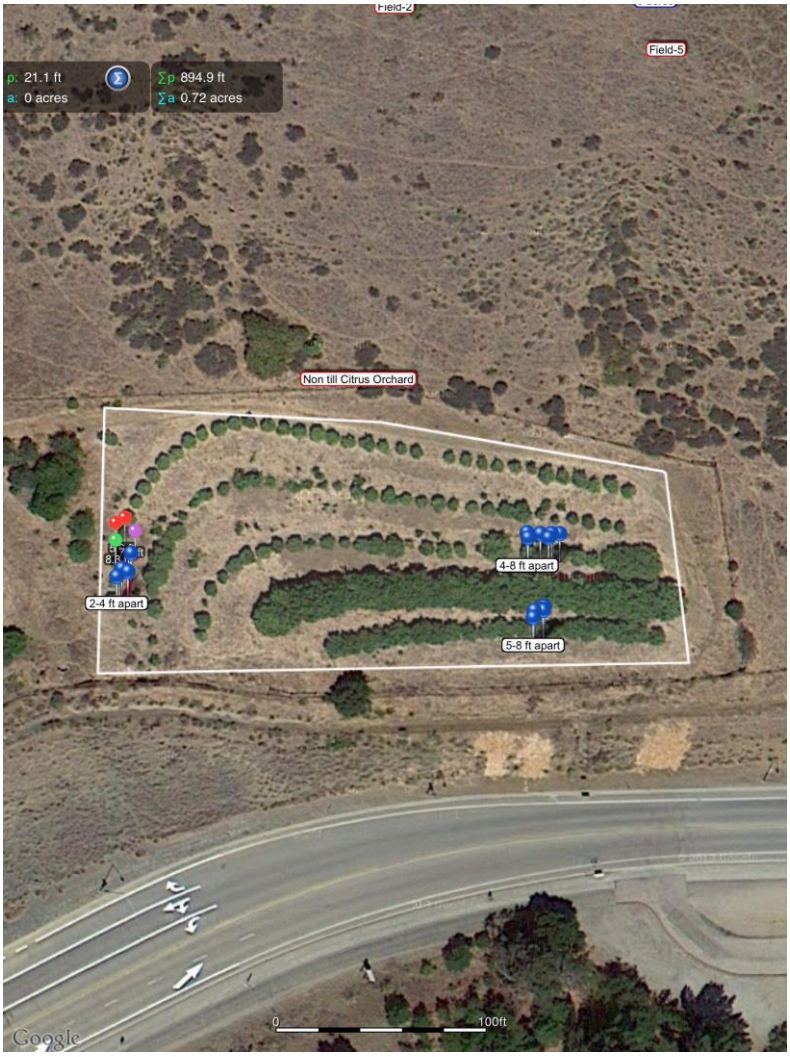

Figure: 2 Non-till citrus orchard observation area.

Most of the activity was on the West and South ends of the field. The area for the experiment in the tilled soil was near radio tower hill Cal Poly's campus. There is an aerial view of the field outlined by a white line (See figure 2). The field is abut an acre and planted with citrus trees. The study was conducted over nine weeks and the results of the gopher activity are recorded below.

This table shows the gopher intrusion in tilled soil, the number of holes, and the amount of movement week by week. The Gophers were able to move more freely in the tilled soil, the gophers on average moved of 11 inches through the soil See table 2.

Table 2 Non tilled soil data

Date	Number of Holes	Movement in Inches
5 October 2015	30	6 to 8 inches from old holes
19 October 2015	33	7 to 14 inches from old holes
2 November 2015	35	No movement *heavy rain
16 November 2015	38	12 to 15 inches from old holes
30 November 2015	39	18 inches from old holes

Figure 2.1:

Gopher hole in no-till soil

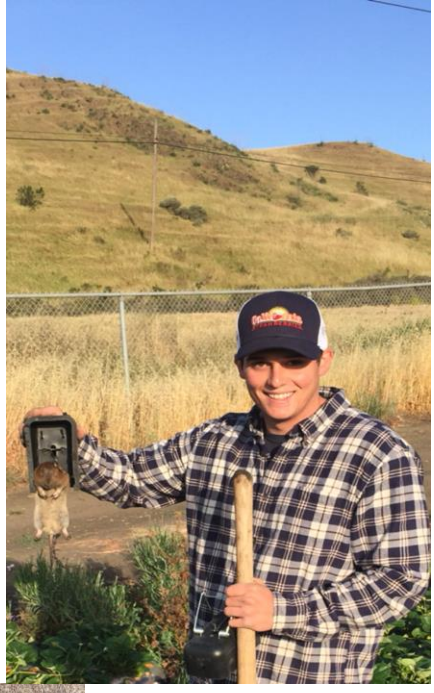

Figure 2.2:

Kenny's kill of the day

Figure 2.3:

No-till soil gopher holes

Figure 2.4:

No-till soil gopher holes and damage shown above.

Chapter Five

Summary and Conclusion

California is the number one cash receipt producing state in agriculture. California has the moderate climate creating the best for crop production, with the vast farming commodities for growth of crops there are a large amount of pests in the state that prevent the highest yield. Vertebrate pests while not as numerous or pervasive as disease or invertebrate problems, can occasionally be a real concern. Gophers, for example, were the main focus in the research conducted for this senior project. With the results collected through the nine week study the gopher intrusion in no till soil was slower than the gopher intrusion on the fresh tilled soil, however the gopher damage that was done is easier to correct in the fresh till soil because collapsing the holes is easier to manage.

Conclusion

In this experiment, till soil and no-till soil is beneficial for controlling gophers within a cropping system. For a conventional field, where herbicide use is used to control weeds no till would be beneficial for controlling gopher intrusion. Keeping the soil packed and difficult for the gophers to move more freely. Furthermore farm roads surrounding the field would benefit for controlling gophers, keeping the soil packed and creating a 10-foot wide road would slow down the rate at which the gophers can enter the field. It is also recommended to poison, trap, and exclude gophers if they do enter the field. Following the Laws and Recommendations from the Department of Pesticide Regulations through the county when applying any bait for the gophers. Finally, in a conventional field where herbicide is used control weeds no till will be most beneficial for the conventional cropping system to control gophers.

If in an organic cropping system it may be more beneficial to till your soil to keep weeds clear and combat the gopher as they intrude via poison, trapping and exclusion. Also till in the soil will cause burrow destruction which is important part of gopher management. Using a PCA will give you recommendations on any organic herbicides and organic vertebrate pest management intrusion methods that will help keep your fields clean from weeds and gophers. Overall in an organic cropping system tilling the soil maybe be a better method for overall field health.

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